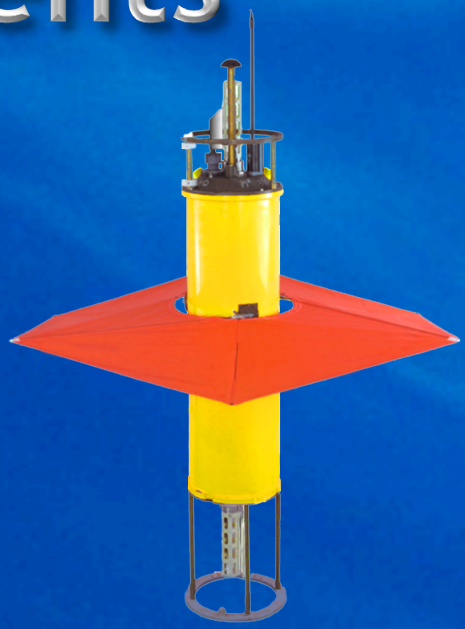
High-resolution near-surface turbulence measurements using Lagrangian floats



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"The research questions to be addressed in SPURS are:

1. What are the physical processes responsible for the location, magnitude and maintenance of the subtropical Atlantic sea surface and subsurface salinity maximum?
   a) How is *S*-max formed and dissipated?
   b) Given the seasonal cycle in $(E-P)/h$, why there is no seasonal cycle in SSS?
   c) What processes give rise to the sub-seasonal salinity changes observed at 20°N, 38°W?
   d) What is the propagation pathway for salt?
   e) What is the salinity balance of the surface layer on a monthly to seasonal time scale and a regional to meso- spatial scale?
2. How will the ocean respond to changes in thermal and freshwater forcing associated with a changing climate?
   a) How will the shallow meridional overturning circulation be altered?
3. What is the nature of the cascade of salinity variance from the largest (climate) scales down to dissipation scales of a few millimeters?
4. What new information must be supplied to ocean models in order for these questions to be adequately examined?

Adapted from http://spurs.jpl.nasa.gov

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Scientific questions

to be addressed by Lagrangian Floats

Vertical structure of the upper ocean BL

Turbulence levels

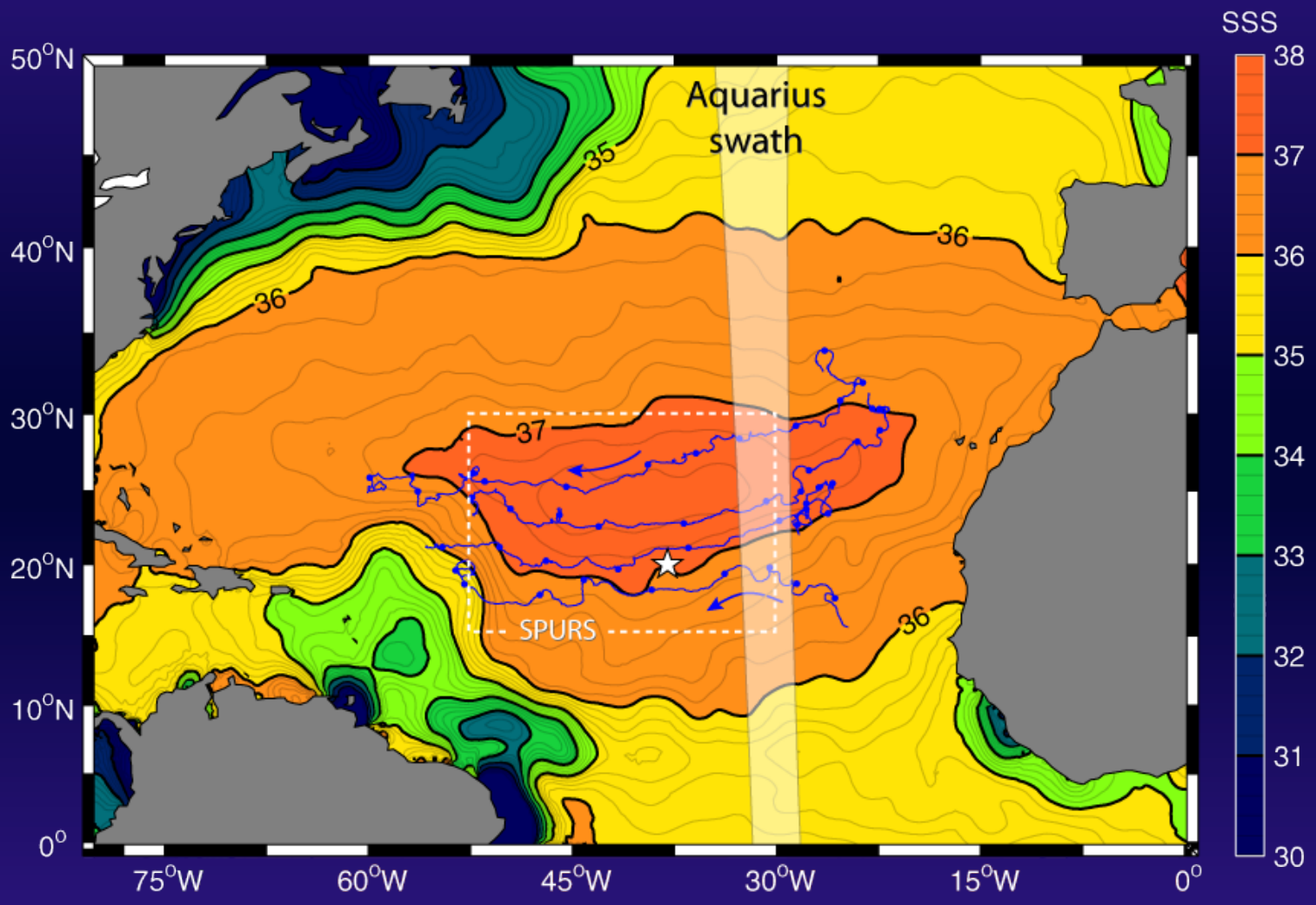
Air-sea and entrainment fluxes

Relationship to atmospheric forcing on a variety of time scales

How do these factors set the structure of S-max?

Study S-max formation and dissolution in Lagrangian frame

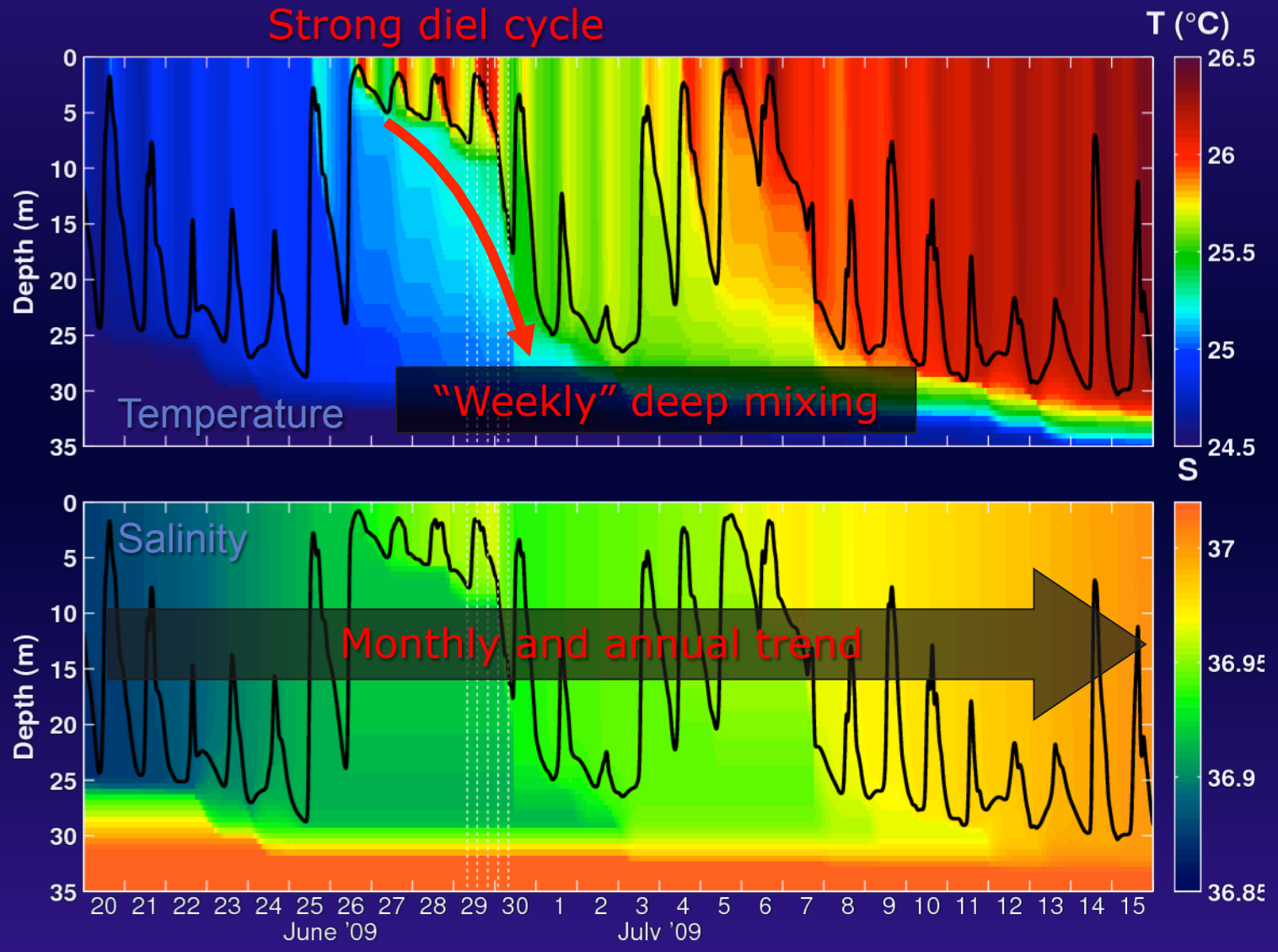
Floats cross S-max area in 7-12 months



Climatological summer sea surface salinity (World Ocean Atlas 2005)

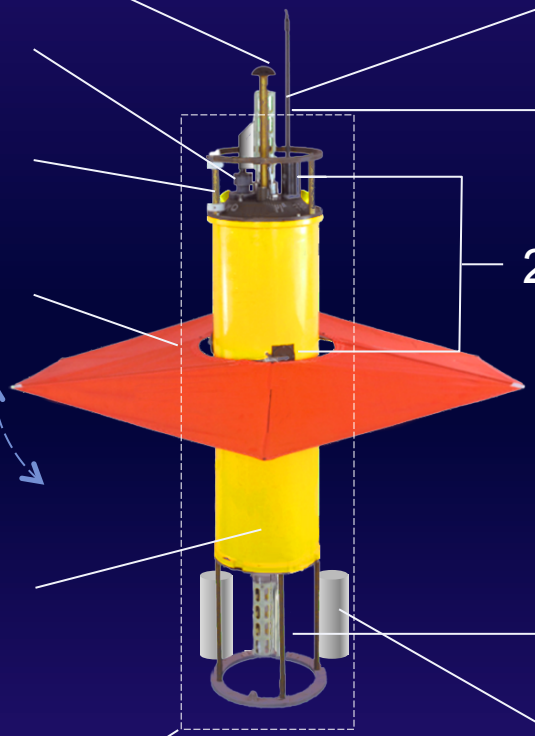
ML variability: day, week, month…

PWP mixed layer model forced by PIRATA mooring fluxes



SPURS Lagrangian Float design

2 floats will be built at APL



Iridium + GPS

Solar radiation

Hydrophone (ambient noise)

Folding drogue

Buoyancy control
(profiling or neutral within 1g)

Aggressive anti-fouling
("100% coverage")

Surface salinity

2 x Pressure

2 x CTD

Extra battery packs
(for 1 year endurance)

Lagrangian Float measurements

Upper-ocean profiling:

- -"deep" CTD (upper 50-100m)
- -"shallow" CTD (high-res profiles in the upper 10m)
- - shortwave radiation profiles

Lagrangian drifts in boundary layer:

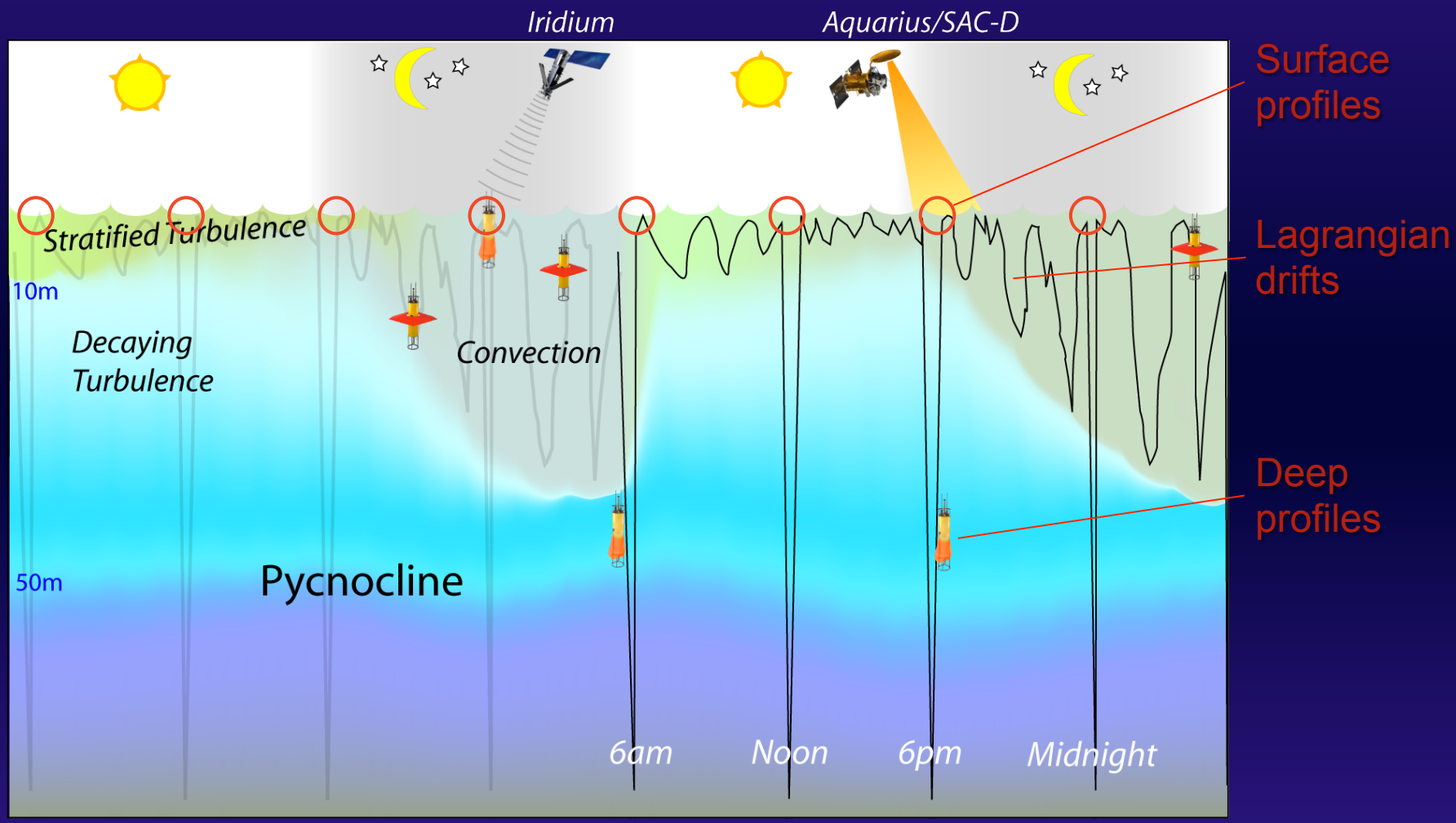
- - profiles of vertical turbulence kinetic energy ($\langle W^2 \rangle$)
- - fluxes from Reynolds' covariances ($\langle W'S' \rangle$, $\langle W'T' \rangle$)
- - fluxes from energy and scalar dissipation rates (ε and χ)

Ambient noise spectra:

- - wind / wave breaking / surface roughness
- - rainfall

Float mission

Flexible, adaptable, synchronized with *Aquarius*



Analysis

Boundary layer budgets

- surface flux
- entrainment
- storage
- residuals (lateral mixing)

Surface flux tuning & comparison

Boundary layer modeling

- LES modeling to test new boundary layer models

We will need…

Ship time for deployment, swap, and recovery

- can do 1 yr with no recovery
- prefer 6 months, with recovery

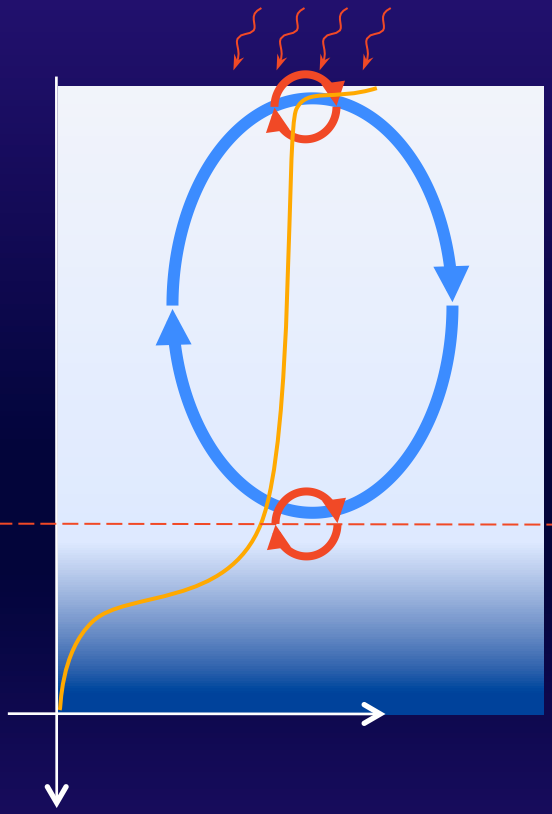
Regional air-sea fluxes & waves (hind- and forecast)

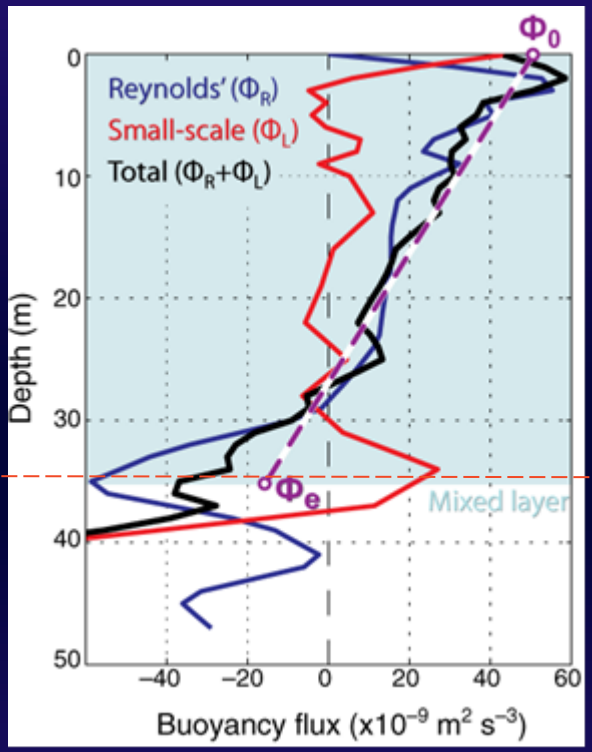
SST/SSH/SSS remote sensing (for mission planning)

Contingency planning (hurricanes, search & rescue)

Lagrangian flux calculation

Lagrangian floats allow direct measurement of all the terms of 1D tracer budget





$$\frac{\partial \langle T \rangle}{\partial t} = -\frac{\partial \langle wT' \rangle}{\partial z} + \left\langle \frac{DT}{Dt} \right\rangle = -\frac{\partial}{\partial z}\left[\Phi_R + \Phi_L\right]$$

Diel profile evolution

PWP mixed layer model